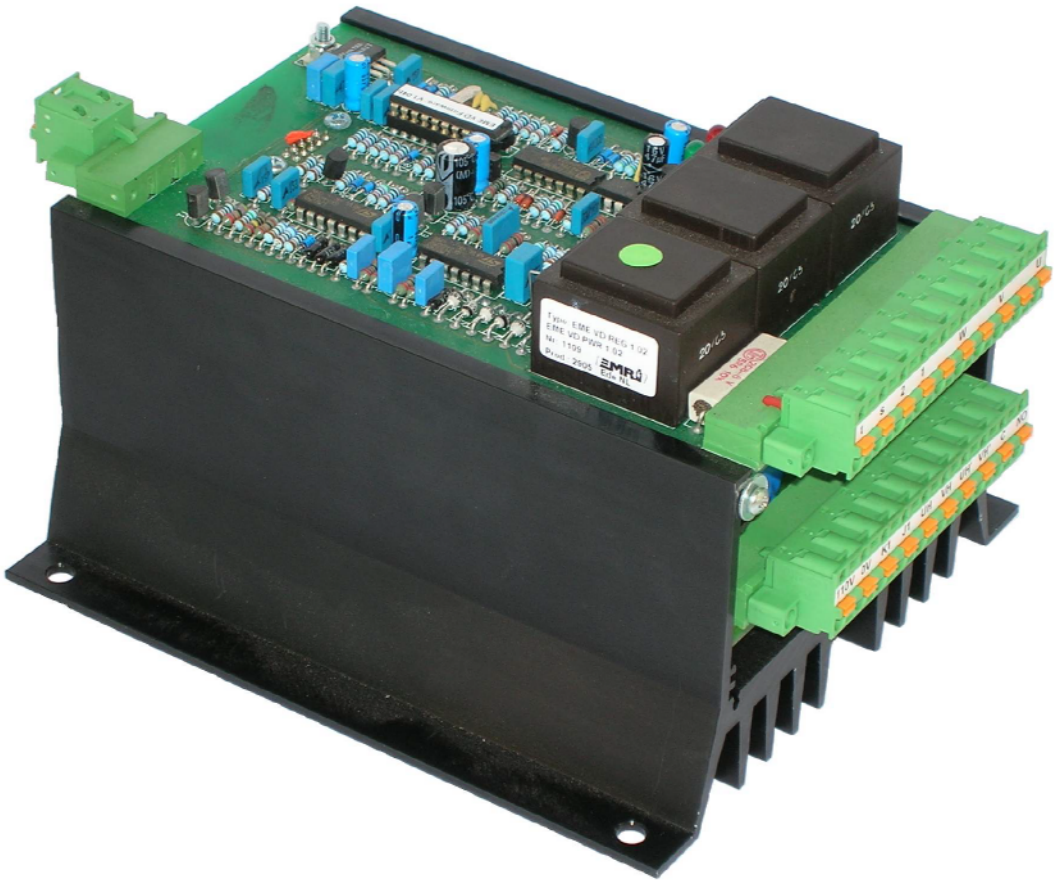
EME VD V1.02

Voltage regulator for generators



January 2006

Instruction Manual

WARNINGS

WARNING

The system should not be installed, operated, serviced or modified except by qualified personnel who understand the danger of electric shock hazards and have read and understood the user instructions

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WARNING

Never work on a LIVE generator. Unless there is another person present who can switch of the power supply or stop the engine

WARNING

Dangerous voltages are present at the voltage regulator board. Accidental contact with live conductors could result in serious electrical shock or electrocution.
Disconnect the power source before making repairs, connecting test instruments, or removing or making connections to the voltage regulator or generator.

ELECTRICAL HAZARDOUS VOLTAGES DANGEROUS DO NOT OPERATE WHEN NOT FAMILIAR WITH GENERATORS

The manual does not cover all technical details of the product. Specifications may be modified by the manufacturer without notice. For further information, the manufacturer should be contacted.

Table of contents

1. INTRODUCTION

1.0 General description

This manual contains instructions for installing, operating and maintaining the EME VD automatic voltage regulator (AVR).
The AVR is specifically designed for railway application according EN 50155 in combination with brushless generators 400 V/50 Hz.
It is however very applicable for generator installations where high demands for the accuracy and safety for the generator output are requested.

The AVR is equipped with security functions to protect the generator load and equipment from damage or dangerous situations. Critical protections are implemented redundant. The protection circuits as well as the operational status feedback interface contact are tested upon every power up, before the generator is excited by the AVR.
The AVR is designed to meet the railway requirements described in the EN 50155:2004, rolling stock.
This contains the environmental aspects as well as the electrical aspects such as EMC emission and immunity, supply voltage range, and overvoltage protections.

Under normal conditions the AVR is placed inside the generator but installation in cabinets is also possible.

The AVR is partly software controlled and deliverable with special functions such as soft voltage recovery at voltage dips upon switched on heavy loads, when using soft prime movers such as a hydraulic motor.

The AVR is available for 0-110V_{dc} as well as 0-24V_{dc} supply voltage.

1.1 AVR Layout

The AVR is protected from the environment by an epoxy coating.
The bottom of the AVR has a special Protective Earth (PE) connection surface shown as PE in figure 2.

Connection terminals are locked by screws and are not exchangeable as a consequence of a coding system.

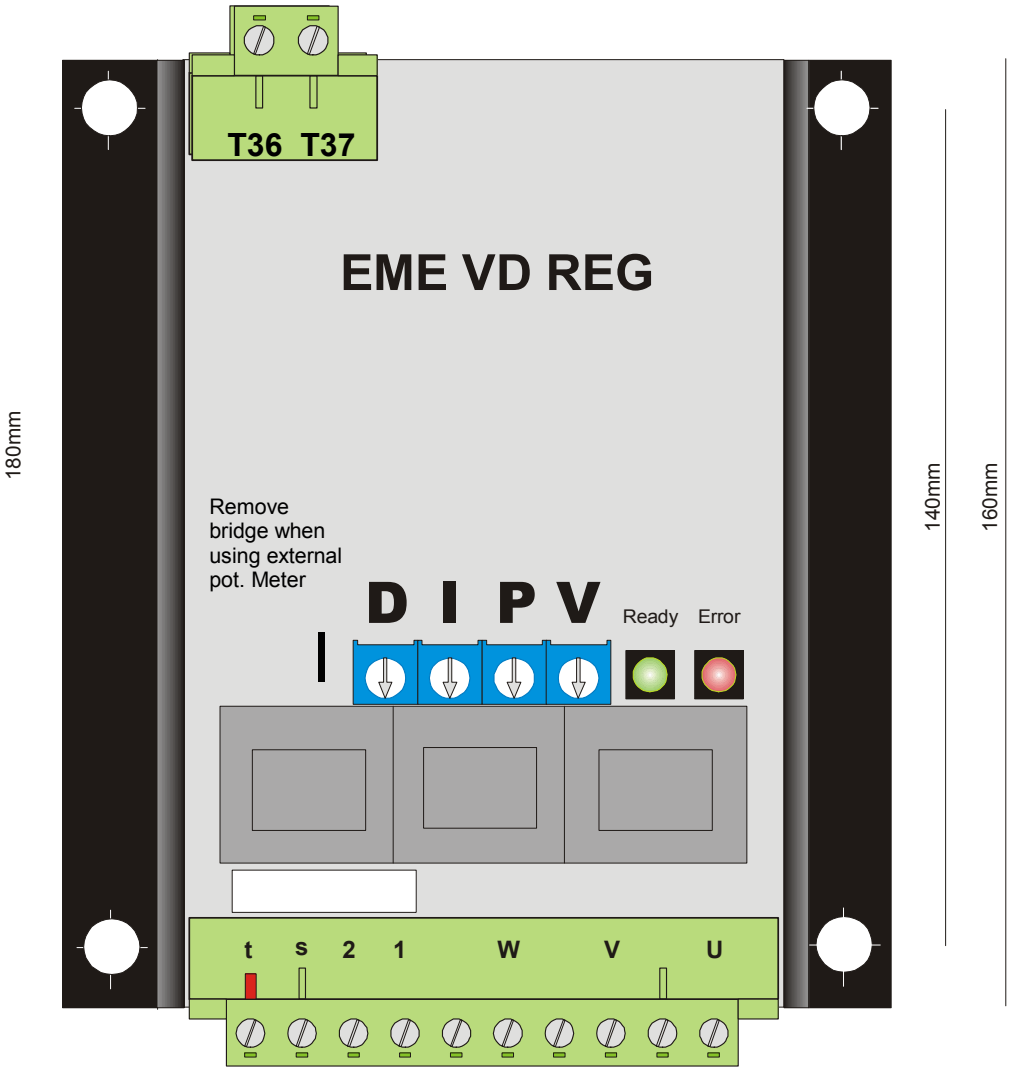


Fig 1. Top view AVR (Measurements in mm)

(AVR layout continued)

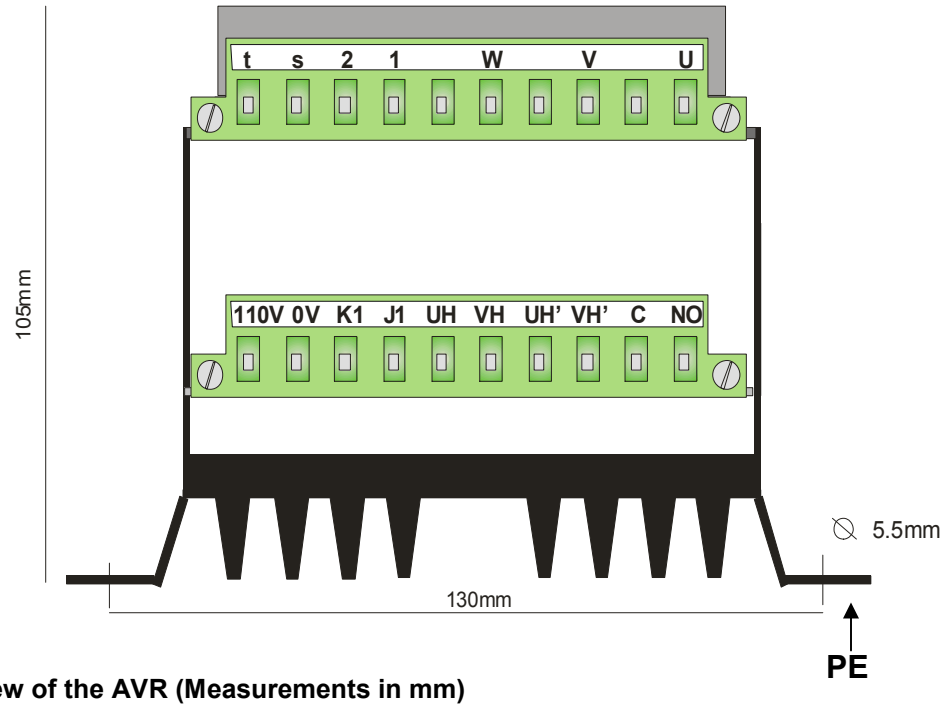


Fig 2. Rear view of the AVR (Measurements in mm)

1.2 Absolute maximum ratings

Symbol	Parameter	Condition	Min.	Max.	Unit
U,V,W	Voltage sensing input	< 30 s. 50 Hz.	-	500	V_{ac}
J1, K1	Field excitation current	Typical 4 A_{dc}		5	A_{dc}
UH, VH UH', VH'	Supply input	1- or 3-phase. or two 1-phase dc - 400 Hertz	20	240	V
R_{field}	Field resistance	@ 100 V_{UH-VH} (rms) @ 230 V_{UH-VH} (rms)	4 10	- -	Ohm Ohm
T_{amb}	Operating ambient temperature	100 % RHD non condensing	-20	+85	ºC
T_{stg}	Storage temperature	95 % RHD non condensing	-45	+85	ºC
NO, C	Operational output	Isolated		5A/30V	DC
T36, T37	Clixon input	Isolated	0		Ohm
1, 2	Droop input	Isolated		0.5	A_{ac}
0-24 V	Electronics supply	Isolated	18	39	V_{dc}
0-110V	Electronics supply	Isolated	77	138	V_{dc}
s, t	External Volt adjust	- 5%	0	5K	Ohm
	Accuracy	THD < 5 %		1 %	

Table 1. Absolute maximum ratings

1.3 Commissioning information

The system should not be installed, operated, serviced or modified except by qualified personnel who understand the danger of electric shock hazards and have read and understood the user instructions.

Defects in the generator or AVR may cause consequential loss. Precautions must be taken to prevent this from occurring.

Never work on a LIVE generator. Unless there is another person present who can switch of the power supply or stop the prime mover.

Dangerous voltages are present at the voltage regulator board. Accidental contact with live conductors could result in serious electrical shock or electrocution.
Disconnect the power source before making repairs, connecting test instruments, or removing or making connections to the voltage regulator.

The unit should be installed with respect to the environmental specifications as well as the rules mentioned in the General installation information.
For safety reasons the voltage LEVEL potentiometer is best turned completely counter clockwise in order to start at the lowest possible voltage.

2. INSTALLATION AND MAINTENANCE

For safety reasons the voltage LEVEL potentiometers are best turned completely counter clockwise in order to start at the lowest possible voltage

2.0 Connection diagram

For a complete wiring diagram see figure 4 on page 12.

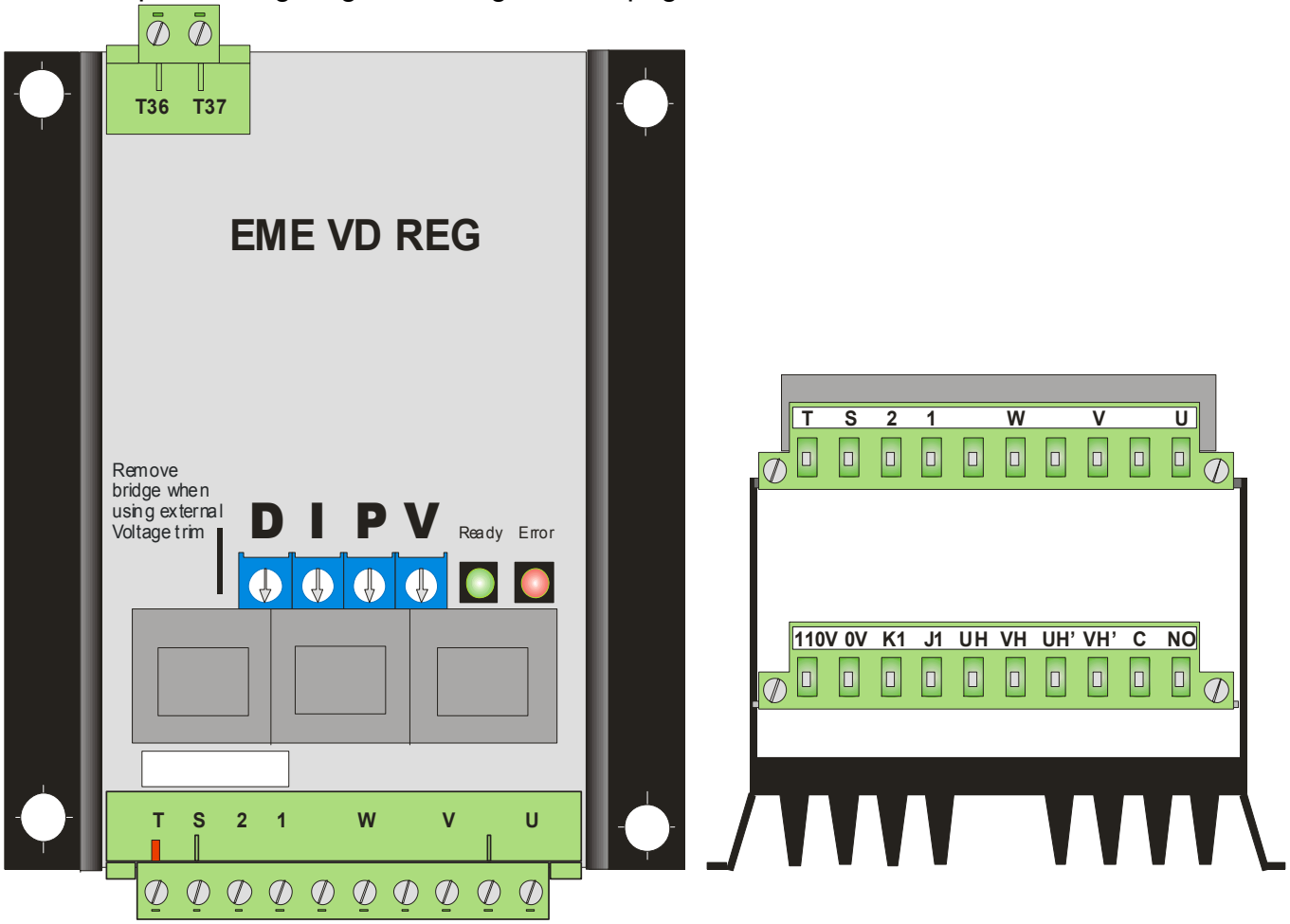


Fig 3. Connectors (top and rear view)

Symbol	Description	Notes
U, V, W	Voltage sensing input	
1 & 2	Droop input	0,5 A_{ac} max (Vphase)
S & T	External connector for remote voltage control	When used, remove bridge
0 – 110 V	External electronic supply	24 V_{dc} also available
K1 & J1	AVR field excitation	
UH & VH	Supply input	
UH' & VH'	Supply input	
C & NO	Status contact	Closed when AVR operational
T36 & T37	Clixon input	Overtemperature when open

Table 2. Connecting diagram

2.1 Running state and LED error codes

☞ **Important: By removing the 110V_{dc} (or 24V_{dc}) power supply, error codes will be lost!**

To read out the error code, the 110V_{dc} (or 24V_{dc}) power supply must remain connected after an error occurred. In order to reset the AVR, remove the 110V_{dc} (or 24V_{dc}) power supply for at least 5 seconds.


Green LED off: Diagnose fault AVR, AVR not running

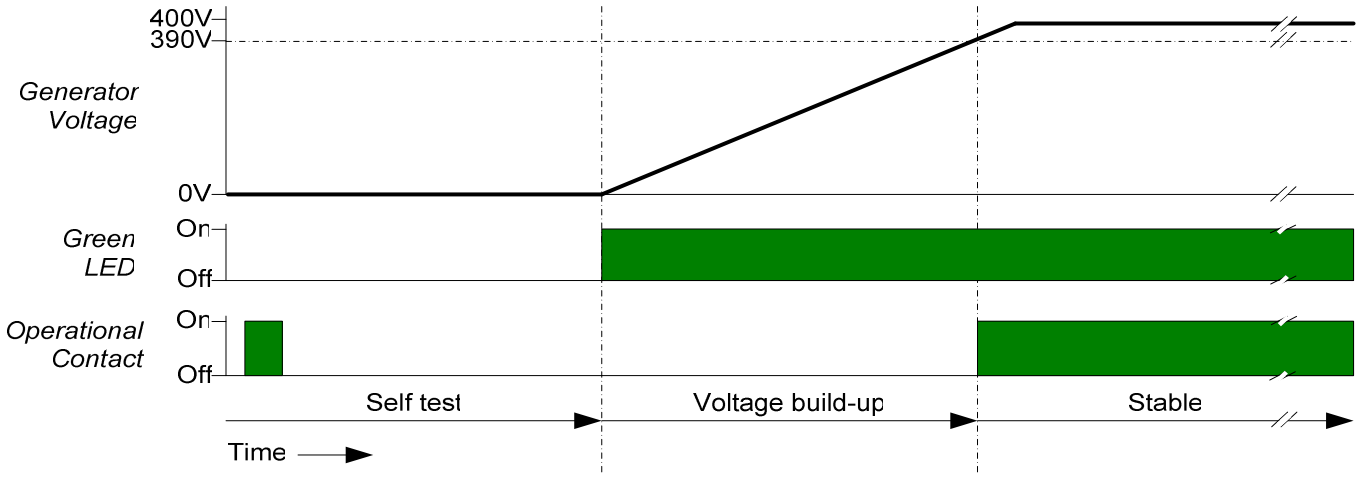

Green LED on: No diagnose fault, AVR running


Red LED on: Fault and error, AVR not running

Table 2. LED status and corresponding error codes

No. of Blinks Red LED	Error Description			
	Green LED off	*Green LED On*		
			Value	Time
1	Operational contact selftest failure	Undervoltage	380V	> 5 s
2	Supply relais selftest failure	Undervoltage	340V	> 1 s
3	Overvoltage selftest failure	Overvoltage	420V	> 5 s
4	Error reset selftest failure	Overvoltage	440V	> 1 s
5	Overtemperature selftest failure	Overvoltage	500V	>0,1s
6	Measurement selftest failure	Underspeed	45Hz	> 5 s
7	Phase loss selftest failure	Overspeed	55Hz	> 5s
8		Over-temperature	T36/T37	> 5 s
9		Phase loss		>0,1 s
10		Critical Error	T36-T37 500V	> 5s >0,1s
	Note: Critical error is either **Overvoltage** or **Overtemperature** (hardwired circuits)			

2.2 Power-up and diagnose



For a successful self test, a remanent voltage of at least 11 V_{ac} phase-phase and a frequency between 45 and 55Hz have to be present.
Power-up self test takes approximately 15 seconds

Error blink code	Green LED off		Green LED on (Ready)	
	Reason	**Solution**	**Reason**	**Solution**
1	Operational contact failure	Replace AVR.	Voltage drop because of too high load	Reduce load Check for short circuit
2	Supply relay failure	Replace AVR.	Voltage drop because of too high load	Reduce load
3	Over voltage failure	Replace AVR.	RPM of prime mover unstable AVR defect	Reduce RPM Replace AVR
4	Error reset failure	Replace AVR.	RPM of prime mover unstable AVR defect	Reduce RPM Replace AVR
5	Temperature failure	Replace AVR.	RPM of prime mover unstable AVR defect	Reduce RPM Replace AVR
6	Measurement failure	Check sensing wiring [1]. Replace AVR.	RPM of prime mover too low Coupling defect	Increase RPM Replace coupling
7	Phase loss failure	Replace AVR.	RPM of prime mover too high Coupling defect	Reduce RPM Replace coupling
8			Over temperature	Check ventilation Clean housing
9			Phase loss Short circuit	Check wiring Check short circuit
10			Critical error	Reduce RPM Check ventilation Clean housing Replace AVR

Note 1: For a successful selftest a minimum remanent voltage of 11V phase-phase has to be present.

Table 3. Error codes and solutions

2.3 ADJUSTING AND FACTORY SETTINGS

When delivered the AVR is ready to use with pre set factory settings. These settings are explained in table 4.

It is not advisable to change these settings because changing the factory settings can damage the generator and cause high voltage. Adjusting may only be done by qualified personnel who understand the danger of electric shock hazards and have read and understood the user instructions

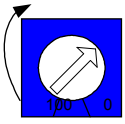
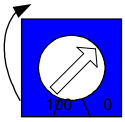
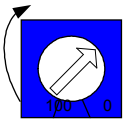
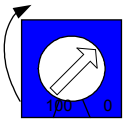
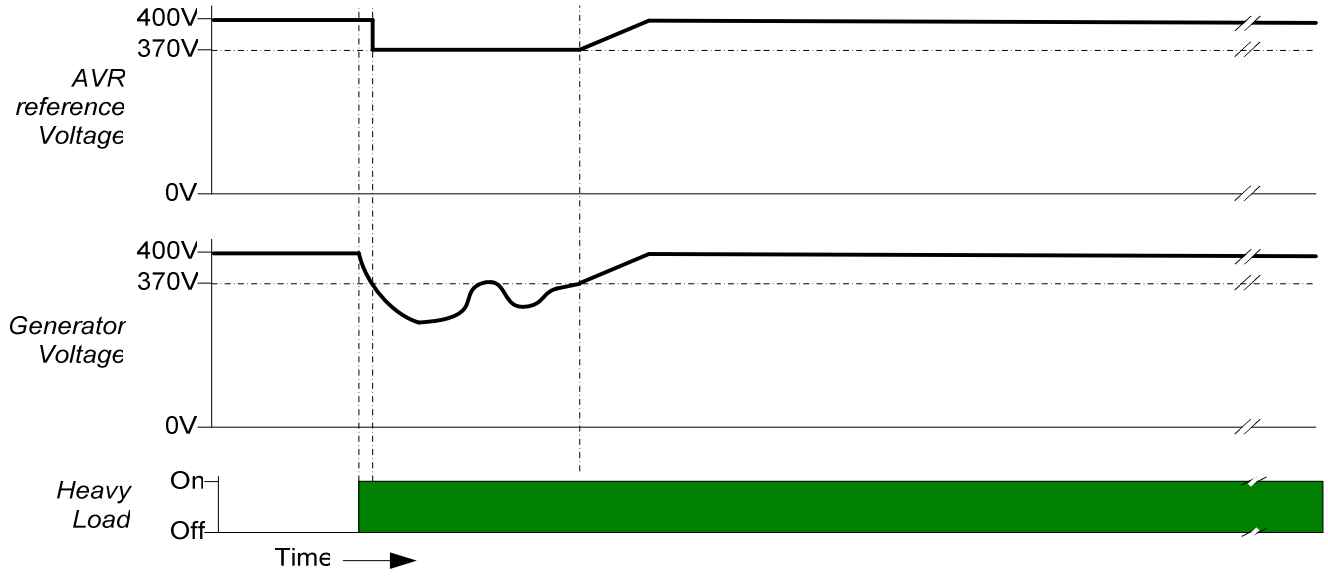
		Factory default	Turning CW	Turning CCW
	**Voltage setpoint:** Adjust the generator output voltage		Increase the output voltage	Decrease the output voltage
		Factory default	**Turning CW**	**Turning CCW**
	**P action setpoint:** Adjust the P-action control characteristic		Increase the Proportional gain action	Decrease the Proportional gain action
		Factory default	**Turning CW**	**Turning CCW**
	**I action setpoint:** Adjust the I-action control characteristic		Increase the Integral action	Decrease the Integral action
		Factory default	**Turning CW**	**Turning CCW**
	**Droop setpoint:** Adjust the voltage droop for parallel operation		Increase the amount of voltage droop	Decrease the amount of voltage droop

Table 4. Adjusting AVR setting (note CW=Clock wise CCW=Counter Clock wise)

2.4 Special functionality*

The AVR has a unique feature of reducing the reference voltage. When a heavy load is switched on and the generator output voltage decreases below 370V, the AVR lowers the reference voltage to 370V. When the generator voltage is equal to the AVR reference voltage again, the AVR builds up to the normal voltage output threshold level again.
This feature prevents the generator from producing a voltage overshoot due to heavy load switches in combination with an over-magnetized generator.



Voltage reference lowering due to heavy load change

*** Not implemented on 24V version**

2.5 Electrical characteristics

Parameter	EME VD 110V_{dc} AVR	EME VD 24V_{dc} AVR
Sensing voltage input	3 x 400 V – 50 Hz	3 x 400 V – 50 Hz
Supply input UH, VH, UH', VH'	85V – 100V_{ac}, 100 – 400 Hz	85V – 100V_{ac}, 100 – 400 Hz
Electronics supply 0-110V_{dc} / 0-24V_{dc}	77 – 138 V_{dc}	18 – 39 V_{dc}
Field excitation current	3,7 A	3,7 A
Field resistance	6 – 10 Ω	6 – 10 Ω
Voltage setpoint range	± 5%	± 5%
Operational contact	30V / 5A_{dc}	30V / 5A_{dc}
Ambient temperature	-20ºC to +70ºC, non condensing	-20ºC to +70ºC, non condensing
Storage temperature	-30ºC to +55ºC, non condensing	-30ºC to +55ºC, non condensing

Stresses above those listed under "Absolute Maximum Ratings" may cause permanent damage to the device. This is a stress rating only and functional operation of the device at those or any other conditions above those indicated in the operation listings of this specification is not implied. Exposure to maximum rating conditions for extended periods may affect device reliability and lifetime.

2.6 Wiring diagram

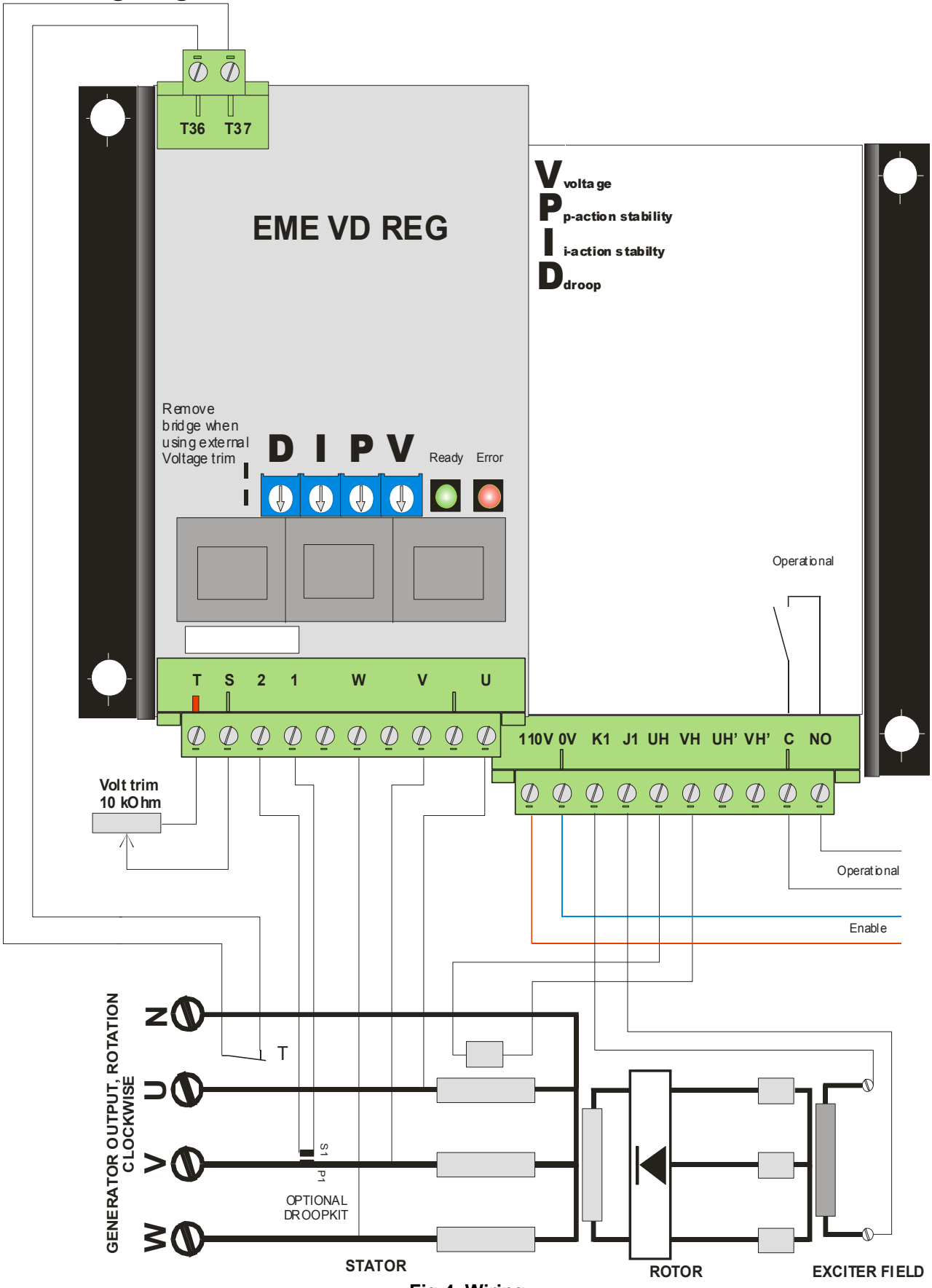
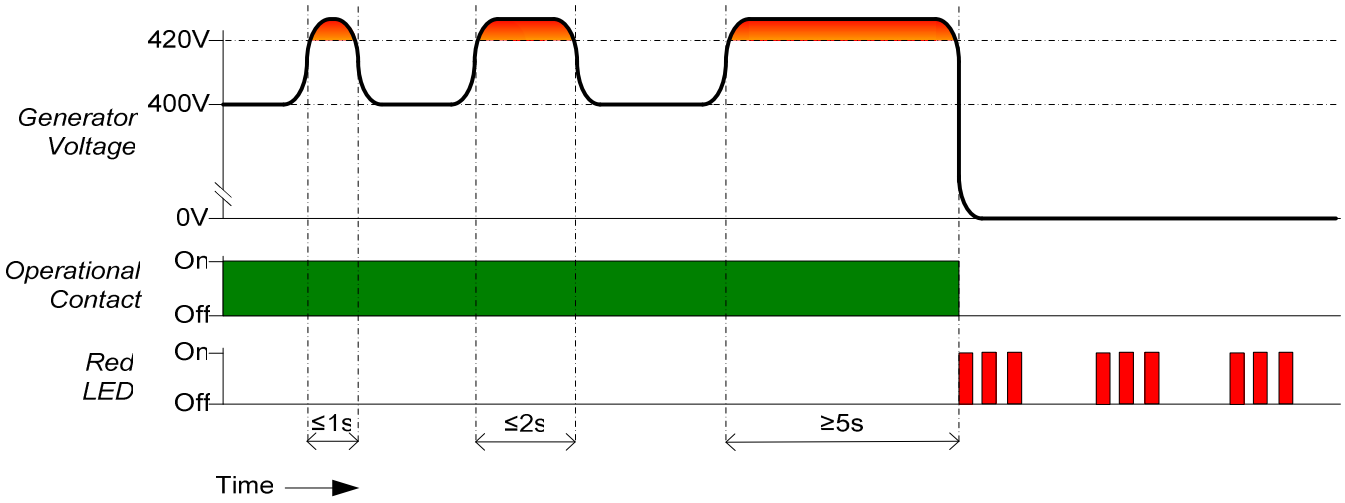


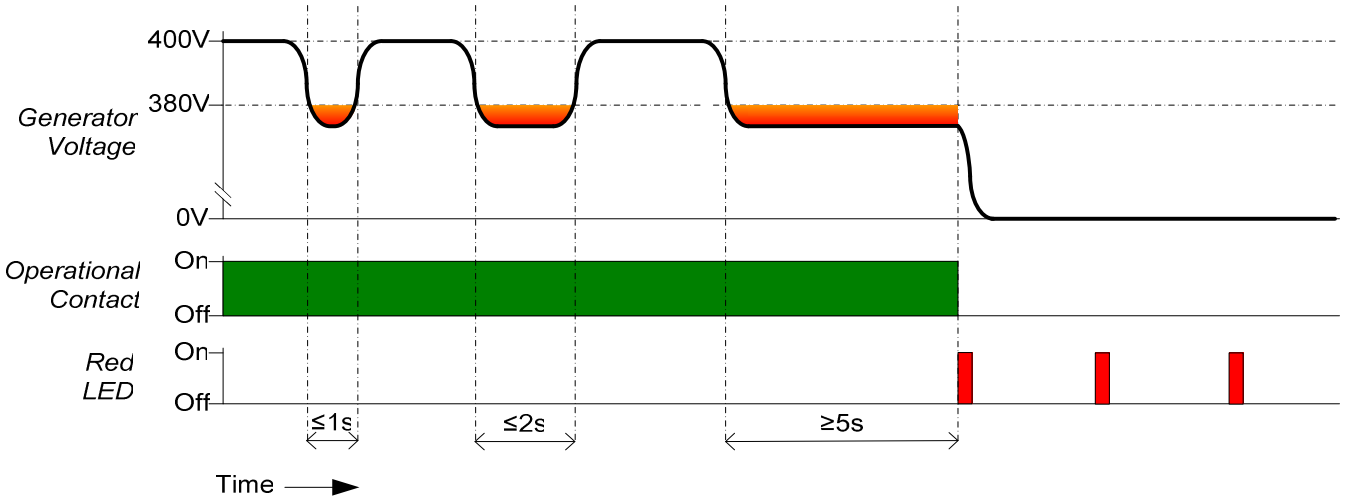
Fig 4. Wiring

2.7 Fault diagnoses

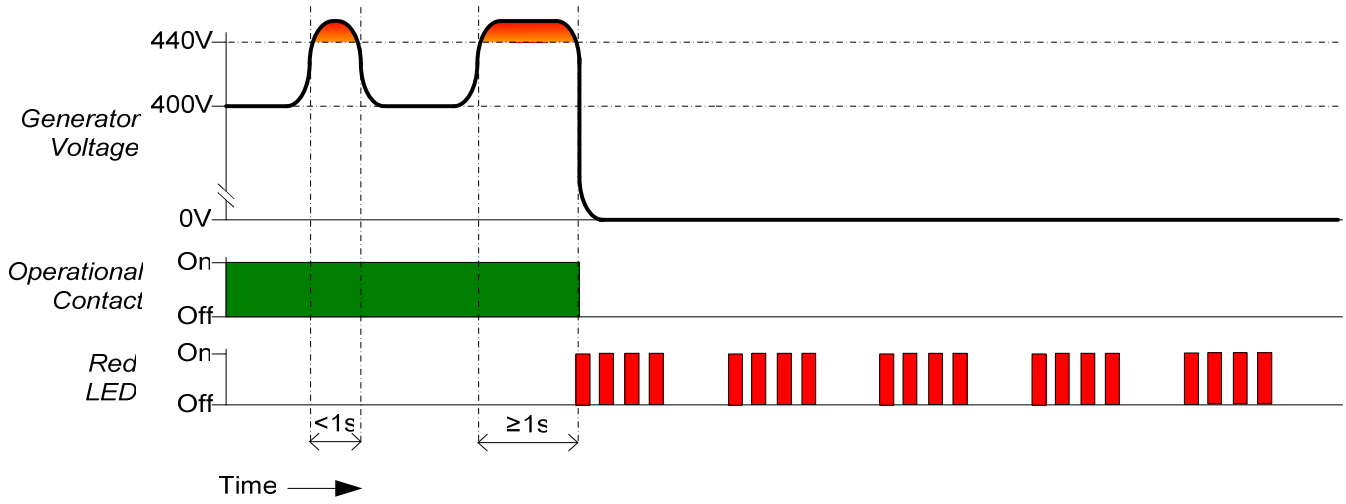
420V Overvoltage



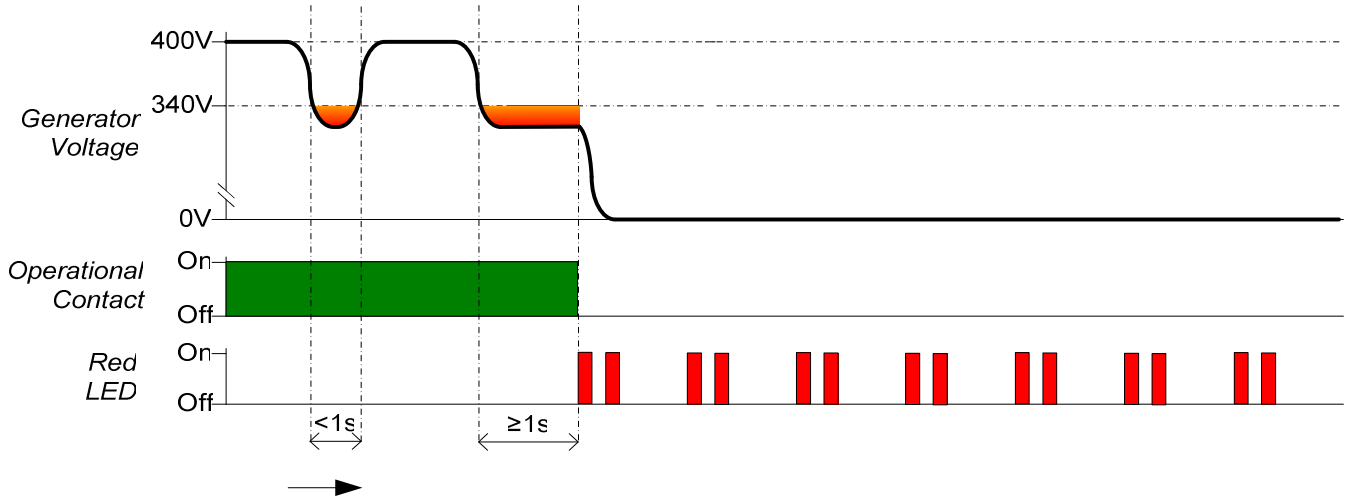
380V Undervoltage



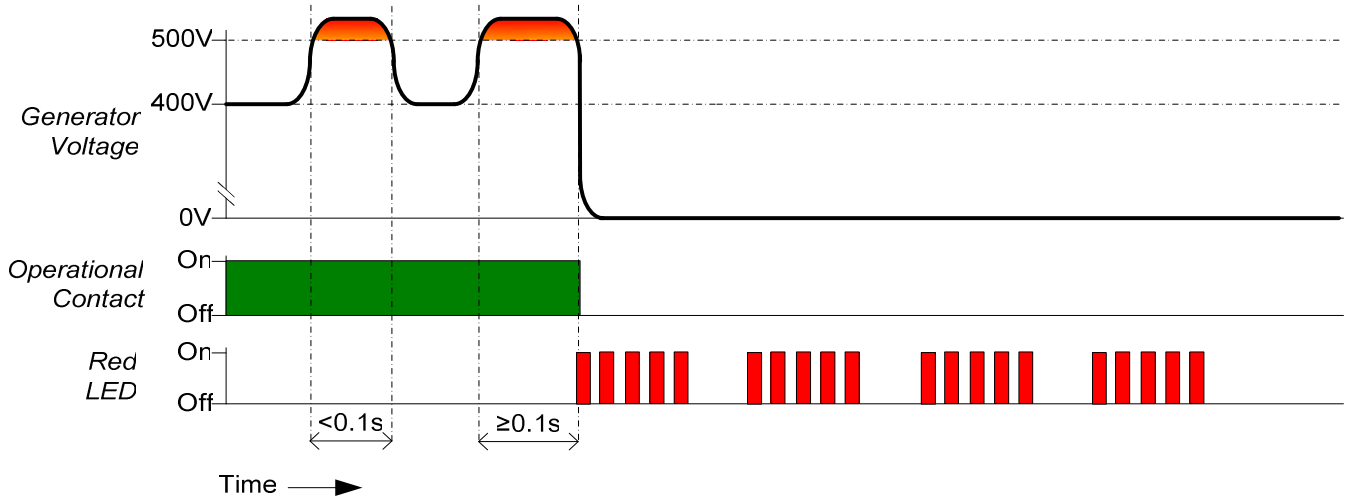
440V Overvoltage



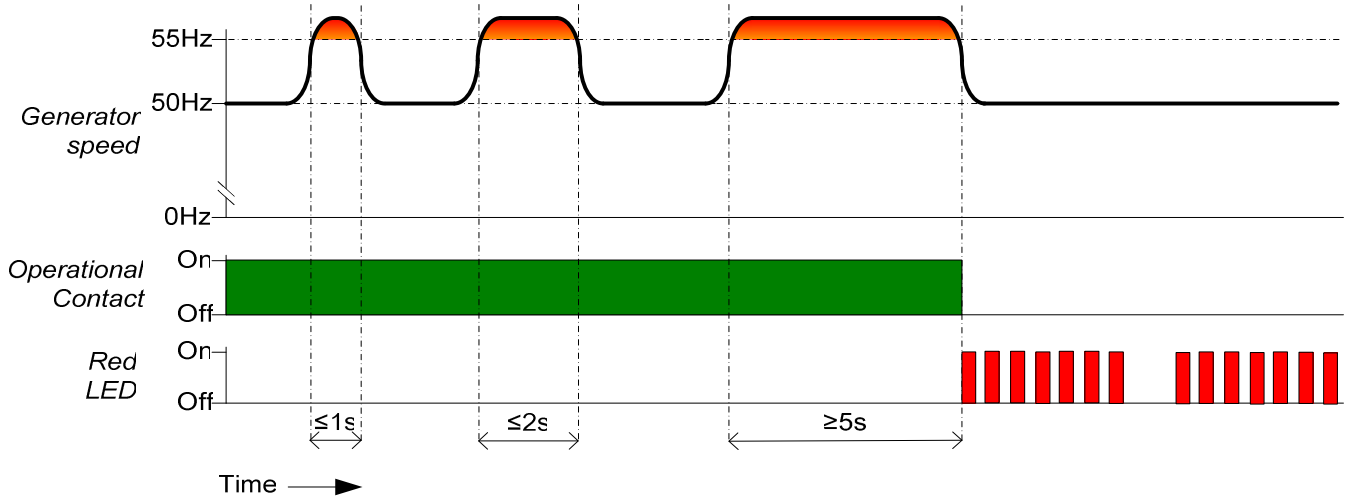
340V Undervoltage:



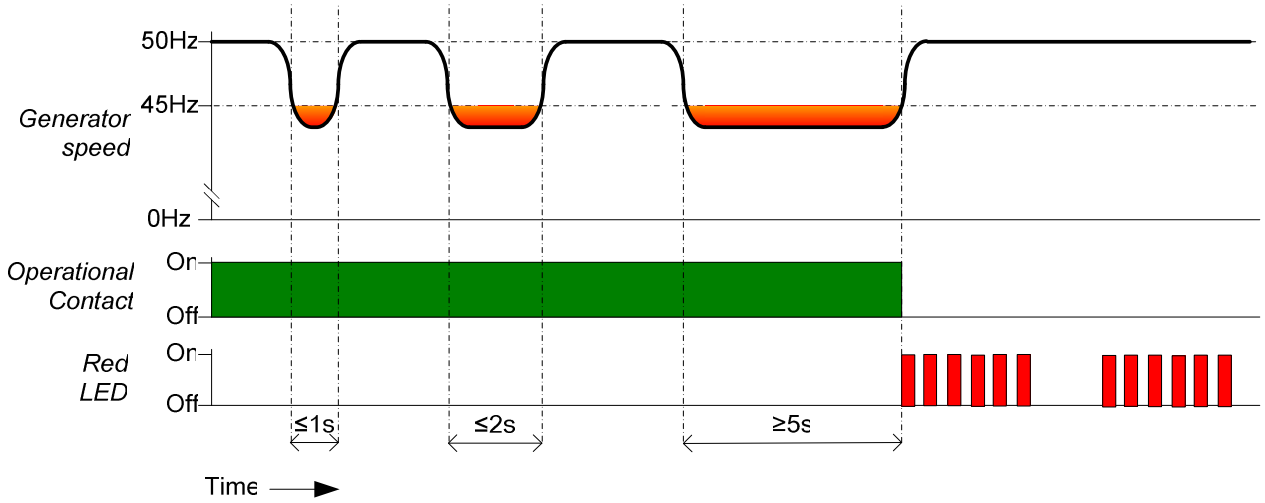
500V overvoltage:



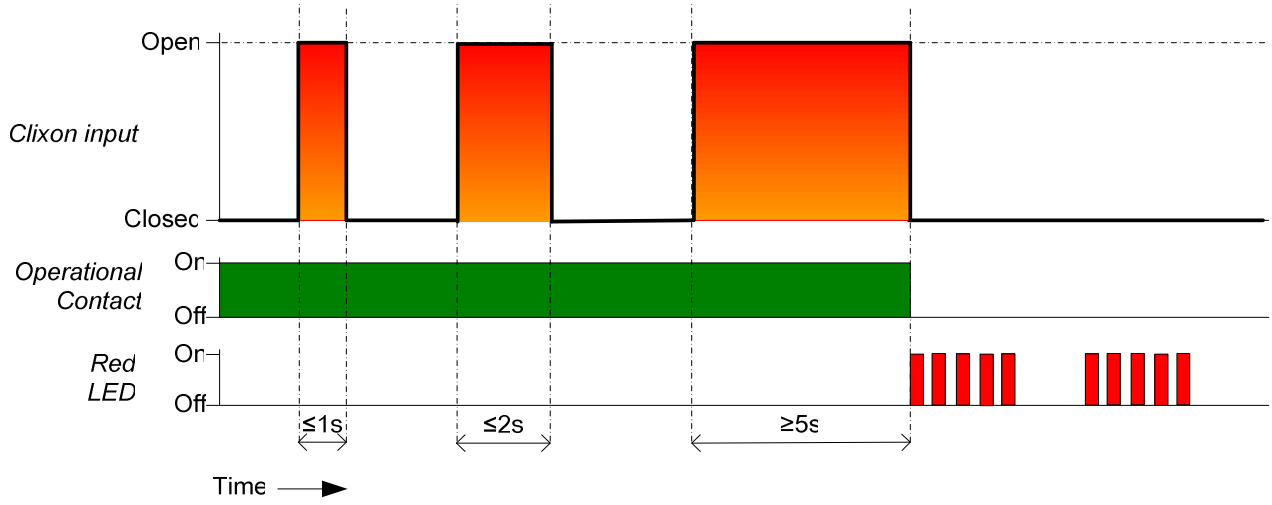
Overspeed

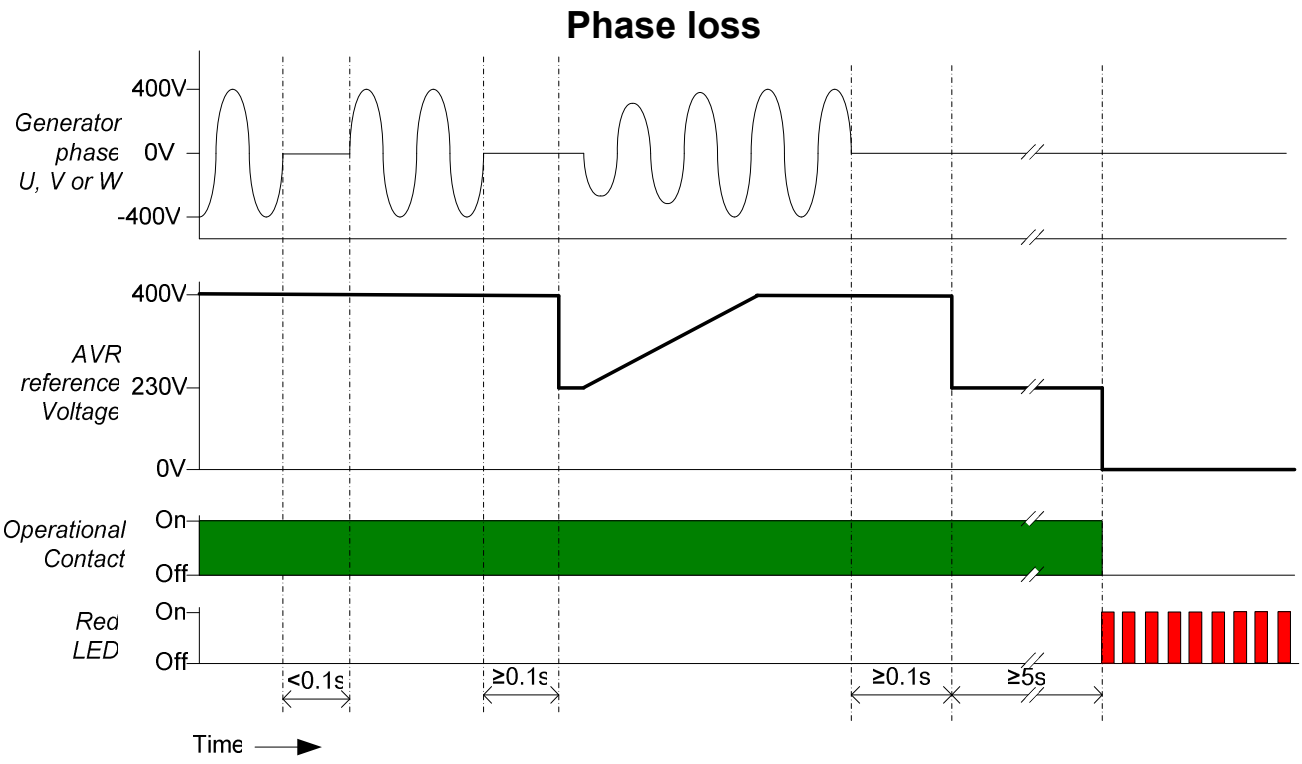


Underspeed



Overtemperature





2.8 Factory settings

After service or repair the AVR is re-adjusted to factory settings which are:

Parameter	Value	Unit
Output Voltage	400	V
Under speed frequency	45	Hz
Over speed frequency	55	Hz
Droop	0	V

2.9 General installation information

Absolute Maximum Ratings

- The Absolute Maximum Ratings are those limits for the device that, if exceeded, will likely damage the device. Exceeding the absolute maximum ratings voids any warranty and/or guarantee.

Mounting

- Mounting of the product should be done in such a way that the absolute maximum ambient temperature rating of the product will never be exceeded.
- Mounting of the product should be done in such a way that maximum cooling (direction of cooling ribs and direction of airflow) is achieved.
- Mounting of the product should be done in such a way that no humid air can flow through the product or condensation occurs.
- Mounting of the product should be done in such a way that dust or other materials or residue will not remain in or on the product.
- Mounting of the product should be done in such a way that the maximum vibration is not exceeded.
- Mounting of the product should be done in such a way that personal contact with persons is impossible.

Wiring

- Diameter size of the wiring should be enough to carry the expected current. Wire insulation should be enough to withstand the expected operating voltages and temperatures.
- To improve EMC emission and immunity, care should be taken for the lay out of the wiring. This in respect to all wiring in the installation.
- Keep current carrying wires as short as possible.
- Keep wires carrying a total sum of zero Ampere close to each other, or in one single cable. E.g. U, V, W or F+ and F-, or Phase and neutral, X1 and X2.
- Avoid current carrying conductors next to sensing or control wiring. Especially current controlled by SCR’s or PWM controlled transistors.
- If sensitive sensing signal cables need to be laid across distance along other cabling, shielded cable is preferred.
  Keep the shield as long as possible and the wiring outside the shield as short as possible. Do not solder or shrink the shield to a regular wire. Connect the original shield to ground at one side with an as large as possible contact surface.

Additional installation information

- When the product is supplied by means of a transformer, it should never be an auto-transformer. Auto-transformers react as voltage sweep up coil and may cause high voltage peaks.
- Standard fit capacitors or over-voltage suppressers across F+ and F- or exciter field terminals inside the generator should be removed.
- When the product is supplied by means of a transformer, it should be able to carry at least the maximum expected current. Advisable is, to have a transformer which can carry twice the maximum expected current. Inductive loads make voltage sacks and peeks into the secondary voltage of a transformer, from which the device may malfunction.
- It is not recommended to apply switches in dc outputs. It is preferred to use switches in the ac supply inputs of devices. In case it is unavoidable to have switches in the dc output of a device, action must be taken to avoid over voltage damage to the device due to contact arcing. Use a voltage suppressor across the output.
- It is not recommended to apply switches or fuses in the sensing lines. Defects can cause high voltage situations due to over-excitation.
- When using a step down transformer in medium or high voltage generators, the transformer should be three phase (if three phase sensing), and the transformer should be suitable for acting as a sensing transformer. If the transformer is unloaded, connect a resistor to avoid voltage waveform distortion.
- The phase relation from the generator to the AVR is important. Also when voltage transformers and/ or current transformers are installed.
- When using a step down or insulation transformer in the droop circuit, phase relation from the generator to the AVR is important.
- CT’s wiring, connected to the AVR should never be grounded.
- Always disconnect electronic products, circuits and people before checking the insulation resistance (Megger check).
- Due to differences in generators impedance’s, EMC behavior is not predictable. Therefore the commissioner / installer should be aware of proper and correct installation.
- Large, highly inductive, exciter stator windings can cause destructive high voltage peaks. Adding a resistor from 10 to 20 times the exciter stator field resistance reduces voltage spikes. If necessary filter can be fitted additionally. (e.g. snubber, RC-network)
- Upon problems during commissioning, faulty behavior or defects in the generator, consult the fault finding manual at our web site
- Some advises may be overdone or seem extraordinary, but since the electrical rules are the same everywhere, these advises are given.